Variable Fiducial Volume Analysis of Solar Neutrino Signal and Backgrounds at SNO

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The SNO Collaboration has two independent methods to extract the solar neutrino flux. Table I summarizes their differences in the energy threshold and fiducial volume for the neutral-current measurement in the pure D_2O phase of the SNO experiment. In the first approach (Method A), the observed Cherenkov light intensity from neutrino interactions is converted to an energy scale equivalent to the Cherenkov light output of relativistic electrons E_e on an event-by-event basis. Only prompt (unscattered) light within a tight time window is used in this energy mapping. In the second approach (Method B), the total number of photomultiplier tube hits (Nhits) within the event trigger window (~400ns) is used as the energy measure. Therefore this approach makes a calorimetric measurement of the total energy deposited by including the scattered light.

	Method A	Method B
Energy	E_e>5.5MeV	Nhits>35 (~4 MeV)
Fiducial Vol.	R<550cm	R<~650cm

Table I: Comparing the energy thresholds and fiducial volumes for the two different analysis approaches.

The choice of the fiducial volume determines how the physics backgrounds are separated from the neutrino signal. The choice of a small fiducial volume of R<550cm in Method A ensures that the background contamination is small. Hence, one can make a small adjustment to the extracted solar neutrino flux by subtracting this small background. In Method B, one needs to incorporate the energy, radial and solar angle distributions of the backgrounds in the signal decomposition process, because the low energy radioactive backgrounds dominate at large radial distances.

We have been applying Method B to the solar neutrino analysis. Event observables (energy, direction and position) are fitted to a linear combination of probability density functions (PDF) for each of the signals and backgrounds. The PDFs are generated by the SNO Monte Carlo simulation program SNOMAN, which has been calibrated by a variety calibration sources. Figure I shows this signal decomposition for a simulated Monte Carlo data set. The agreement between the input and the result of the extraction is good. When we apply this analysis technique to the solar neutrino analysis, the agreement to the results obtained from Method A is excellent.

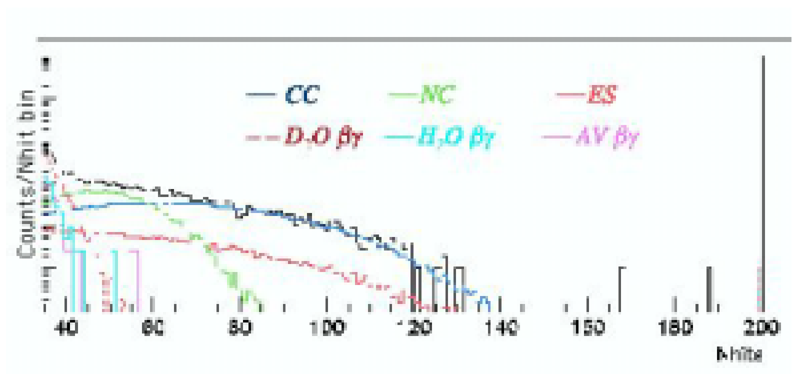

Fig. 1. Decomposition of the solar neutrino and the background signals. In this figure, the Nhits spectrum of the simulated signal and background is decomposed into different components by the neutrino interaction types (CC, NC and ES), or the background source (internal βγ decays from the D_2O, acrylic vessel (AV), and the H_2O.)